Heavy-quark production from Glauber-Gribov theory at LHC

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Abstract. We present predictions for heavy-quark production for proton-lead collisions at LHC energy 5.5 TeV from Glauber-Gribov theory of nuclear shadowing. We have also made predictions for baseline cold-matter (in other words inital-state) nuclear effects in lead-lead collisions at the same energy that has to be taken into account to understand properly final-state effects.

1. Introduction

In the Glauber-Gribov theory [1] nuclear shadowing at low-x is related to diffractive structure functions of the nucleon, which are studied experimentally at HERA. The space-time picture of the interaction for production of a heavy-quark state on nuclei changes from longitudinally ordered rescatterings at energies below the critical energy, corresponding to x_2 of an active parton from a nucleus becoming smaller than $1/m_N R_A$, to the coherent interaction of constituents of the projectile with a target nucleus at energies higher thant the critical one [2]. For production of J/ψ and Υ in the central rapidity region the transition happens at RHIC energies. In this kinematical region the contribution of Glauber-type diagrams is small and it is necessary to calculate diagrams with interactions between pomerons, which, in our approach, are accomodated in the gluon shadowing. A similar model for J/ψ-suppression in d+Au collisions at RHIC has been considered in Ref. [3].

Calculation of gluon shadowing was performed in our recent paper [4], where Gribov approach for the calculation of nuclear structure functions was used. The gluon diffractive distributions were taken from the most recent experimental parameterizations of HERA data [5]. The Schwimmer model was used to account for higher-order rescatterings.

2. Heavy-quark production at the LHC

We present predictions for the rapidity and centrality dependence of the nuclear modification factor in proton-lead (p+Pb) collisions for both J/ψ and Υ in Fig. 1 (the data on J/ψ suppression at $\sqrt{s} = 200$ GeV is taken from [6], where also a definition of the nuclear modification factor can be found). We predict a similar suppression for open charm, $c\bar{c}$, and bottom, $b\bar{b}$, as for the hidden-flavour particles. The observed x_F scaling at low energies of the parameter α (from $\sigma_{pA} = \sigma_{pp} A^{\alpha}$) for J/ψ production, which is broken already at RHIC, will go to a scaling in x_2 at higher energies. This will also be the case for Υ and open charm and bottom.

In Fig. 2 we present predictions for cold-nuclear matter effects due to gluon shadowing in lead-lead (Pb+Pb) collisions at LHC energy $\sqrt{s} = 5.5$ TeV for the production of J/ψ and Υ. The suppression is given as a function of rapidity and centrality. .

References

[1] V.N. Gribov 1969 *Sov. Phys. JETP* **29** 483
[2] K. Boreskov, A. Capella, A. Kaidalov and J. Tran Thanh Van 1993 *Phys. Rev.* D **47** 919
[3] A. Capella and E.G. Ferreiro, `hep-ph/0610313`
[4] I.C. Arsene, L. Bravina, A. Kaidalov, K. Tywoniuk and E. Zabrodin, `hep-ph/0705.1596`
[5] H1 Collaboration, A. Aktas *et al.* 2006 *Eur. Phys. J.* C **48** 715; *ibid.* **48** 749
[6] PHENIX Collaboration, S.S. Adler *et al.* 2003 *Phys. Rev. Lett.* **96** 012304

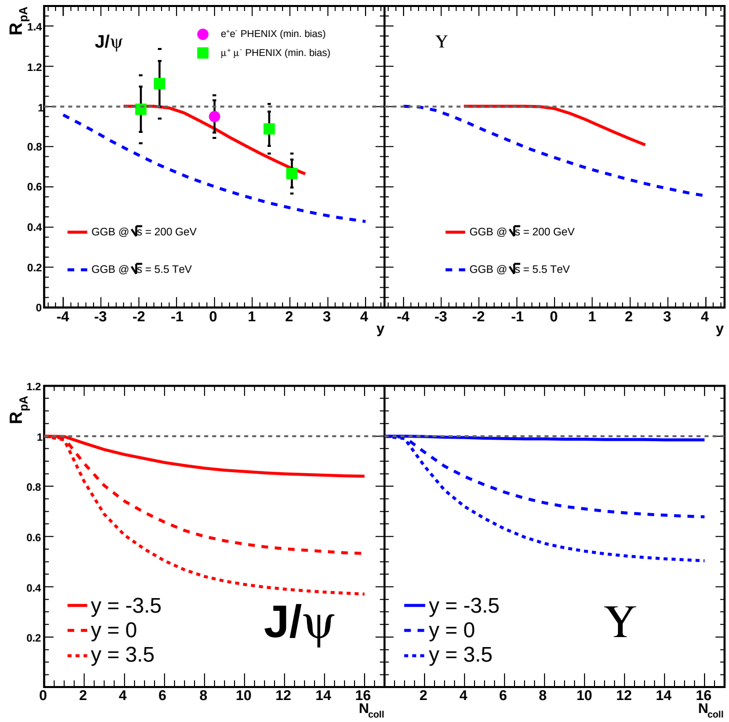

Figure 1. Rapidity (top) and centrality (bottom) dependence of the nuclear modification factor for J/ψ (left) and Υ (right) production in p+Pb (d+Au) collisions at $\sqrt{s} = 5500$ (200) GeV. Experimental data are from [6].

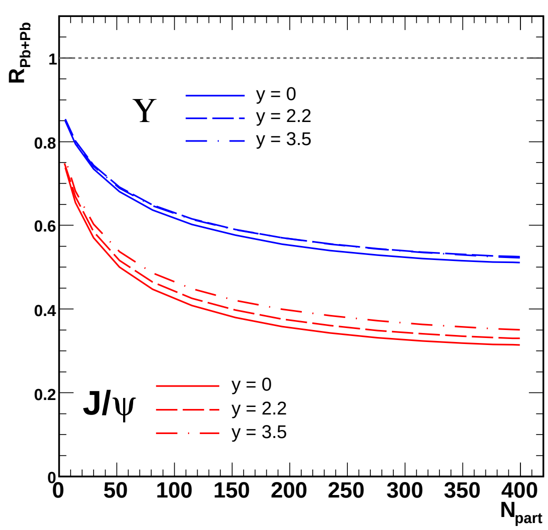

Figure 2. Baseline cold-nuclear matter effects in Pb+Pb collisions at 5.5 TeV for J/ψ and Υ production.